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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
GROUND WATER BRANCH

September 5, 1952

Memorandum:

To: Director, Engineering & Construction, Attn: F. E. Smith
AEC, Idaho Operations Office, Idaho Falls, Idaho
From: R. L. Nace, District Geologist,
U. S. Geological Survey, Boise, Idaho
Subject: Water Supply and Fluid-Waste Disposal at ANPR Site

Information and suggestions are furnished in response to a telephone request from Mr. Frank E. Smith, of your organization, on September 2, 1952. Problems relate to water supply and waste disposal at the Aircraft Nuclear Propulsion Reactor Site on the National Reactor Testing Station, Idaho.

Geologic mapping of the area has been completed by the Geological Survey. Special studies of sediments are in progress. One test hole has been drilled and test pumped near the ANPR Site. A second test hole is in process of drilling, and a third test is planned. Chemical analyses of ground water pumped from the test hole are being made. An interim geologic report on a large area that includes the ANPR Site will be released as soon as drafting of the geologic map is completed. Advance copies of the map, in three sheets, already have been furnished to your office. Mapping of the water table is sufficiently advanced for immediate practical purposes. Results of chemical analyses of water from test-hole 24 will be available within a few days.

The attached information memorandum is a preliminary statement of highlights about the ground-water geology, to meet AEC needs for an immediate conference. The statements are preliminary and have not been approved for release by the Director of the Survey, but the final report on the area probably will not revise these statements materially.

I hope that these notes will meet your immediate needs.

Very truly yours,

R. L. Nace
District Geologist

Encl: 3 copies of Memorandum report

cc: Chief, Ground Water Branch,
Washington, D. C. (in duplicate)
C. V. Theis, Albuquerque, New Mexico

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IDO-22021-USGS
PRELIMINARY RECORDS
SUBJECT TO REVISION

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
GROUND WATER BRANCH

MEMORANDUM:

WATER SUPPLY AND WASTE DISPOSAL AT PROPOSED ANPR SITE NATIONAL REACTOR TESTING STATION, IDAHO

By R. L. Nace

THIS REPORT HAS NOT BEEN EDITED FOR CONFORMANCE WITH GEOLOGICAL SURVEY EDITORIAL STYLE AND USE OF STRATIGRAPHIC NAMES.

PREPARED IN COLLABORATION WITH THE
UNITED STATES ATOMIC ENERGY COMMISSION

BOISE, IDAHO
SEPTEMBER 5, 1952

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PRELIMINARY RECORDS
SUBJECT TO REVISION

WATER SUPPLY AND WASTE DISPOSAL AT PROPOSED ANPR SITE, NATIONAL REACTOR TESTING STATION, IDAHO

By R. L. Nace

Water Demand and Volume of Waste

Anticipated water-demand for facility: About 1,000 gallons a minute firm supply, plus 1,000 gpm standby and emergency supply. Volume of non-toxic industrial-waste fluid: Not known; may approach 1,000 gpm at times. Volume of ordinary sanitary waste fluid: Not known; relatively small and probably about 20 gpm.

Basic Problems

Ground water is the sole accessible source of water supply for the ANPR. The ground also is the only feasible place for ultimate disposal of large volumes of industrial fluid waste. The following topics therefore are of basic importance:

1. Adequacy of the ground-water reservoir to supply perennially the expected draft by pumpage.
2. Hydraulic gradient; direction and velocity of underflow.
3. Desirable locations, construction characteristics, and spacing of water-production wells.
4. Depth to water, drawdown during pumping, and total pumping lift in wells of the specified capacity.
5. Chemical quality of the ground water.
6. Feasible types of fluid-waste disposal facilities.

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7. LOCATIONS FOR WASTE-DISPOSAL FACILITIES AND THEIR SPACE RELATIONS TO OTHER FACILITIES, BOTH IN THE ANPR AREA AND AT OTHER PRESENT AND POTENTIAL REACTOR AREAS IN THE NRTS.

INFORMATION IS NOT AVAILABLE ABOUT PROPOSED LOCATIONS FOR SPECIFIC PARTS OF THE ANPR FACILITY. THEREFORE DEFINITE LOCATIONS CANNOT BE RECOMMENDED FOR WELLS AND WASTE-DISPOSAL WORKS. THE PRINCIPLE CRITERIA FOR SELECTING SITES, HOWEVER, ARE RELATIVELY SIMPLE, AND AVAILABLE INFORMATION IS ADEQUATE TO GUIDE GENERAL PLANNING APPLICATIONS OF THESE CRITERIA.

Adequacy of the Ground-Water Reservoir

AN ADEQUATE WATER SUPPLY IS AVAILABLE AT THE ANPR SITE. CAPACITY IS SUFFICIENT TO SUPPLY ALL FORESEEN NEEDS AND MUCH LARGER FUTURE CONTINGENT NEEDS. THE TOTAL SUPPLY OF GROUND WATER THAT IS PERENNIALLY AVAILABLE AT THE ANPR SITE IS NOT ACCURATELY KNOWN, BUT IT IS EQUAL TO MANY TIMES THE EXPECTED DEMAND OF THE PROPOSED REACTOR. THE WATER-BEARING MATERIAL IS CHIEFLY SNAKE RIVER BASALT, MANY LAYERS OF WHICH STORE AND TRANSMIT GROUND WATER VERY READILY. THE BODY OF GROUND WATER BENEATH THE ANPR SITE IS PART OF A LARGER BODY THAT UNDERLIES THE ENTIRE SNAKE RIVER BASALT PLAIN IN SOUTHERN IDAHO. THE NRTS OCCUPIES A SEGMENT OF THE PLAIN THAT IS NEAR SOURCES OF SUBSTANTIAL RECHARGE BY UNDERFLOW FROM ADJOINING MOUNTAIN AND VALLEY AREAS. GROUND WATER IN THE NORTHERN PART OF THE NRTS IS RECHARGED CHIEFLY BY UNDERFLOW FROM THE VALLEY OF BIRCH CREEK, AND FROM OTHER AREAS NORTH OF THE NRTS.

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GEOLOGICAL SURVEY TEST-HOLE 24, DRILLED IN 1952 TO THE DEPTH OF 326 FEET, IS IN THE NW¼SE¼ SEC. 13, T. 6 N., R. 31 E. THE DRILL PENETRATED ABOUT 50 FEET OF UNCONSOLIDATED FINE-GRAINED SEDIMENTS, AND 276 FEET OF SNAKE RIVER BASALT. FRACTURED AND PERMEABLE ZONES WERE PRESENT AT VARIOUS LEVELS IN THE BASALT, BOTH ABOVE AND BELOW THE WATER TABLE, WHICH IS 214 FEET BELOW THE LAND SURFACE; THUS THE HOLE PENETRATES 112 FEET OF BASALT IN THE ZONE OF SATURATION. A CONDENSED DRILLER'S LOG IS APPENDED. STUDY OF THE CUTTINGS AND PREPARATION OF A GEOLOGIC LOG IS IN PROGRESS. THE WELL CONTAINS 326 FEET OF 8¼-INCH I. D. CASING THAT IS PERFORATED AND SURROUNDED BY AN ARTIFICIAL GRAVEL PACK BELOW THE WATER TABLE. THE PERFORATIONS PROVIDE ABOUT 4.2 SQUARE FEET OF WATER-ENTRANCE AREA THROUGH THE CASING.

ON AUGUST 26 AND 27, 1952 THE WELL WAS TESTED BY PUMPING FOR 24 HOURS AT AN AVERAGE RATE OF ABOUT 350 GPM. DRAWDOWN AT THE END OF THE TEST WAS 4 FEET. THE NEAREST WELL IN WHICH OBSERVATIONS COULD BE MADE DURING THE PUMPING TEST WAS GEOLOGICAL SURVEY TEST-HOLE 7, ABOUT 1⅛ MILES SOUTHWEST OF TEST-HOLE 24. INFLUENCE FROM PUMPING NUMBER 24 WAS NOT APPARENT AT NUMBER 7.

HYDRAULIC GRADIENT; DIRECTION AND VELOCITY OF UNDERFLOW

TEST-HOLE 24 IS THE NORTHERNMOST POINT OF ESTABLISHED CONTROL ON THE WATER TABLE IN THE NRTS. OTHER CONTROL POINTS ARE FROM 2 TO 8 MILES DISTANT IN DIRECTIONS THAT RANGE FROM SOUTHWEST TO NORTHEAST. INFORMATION IS NOT AVAILABLE FOR AREAS NORTH AND NORTHWEST OF TEST-HOLE 24. THIRD-ORDER LEVELING HAS NOT BEEN COMPLETED IN THIS AREA,

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BUT PRELIMINARY LEVELING INDICATES THAT THE ALTITUDE OF THE WATER TABLE AT TEST-HOLE 24 IS ABOUT 4,580 FEET ABOVE MEAN SEA-LEVEL DATUM OF 1929. PRELIMINARY INFERENCES, BASED ON SCATTERED DATA FOR THE PART OF THE NRTS IN TPS. 6 AND 7 N., ARE AS FOLLOWS:

1. THE CONFIGURATION OF THE WATER TABLE ~~GRADIENT~~ IS FAIRLY SIMPLE, WITHOUT APPARENT REGIONAL COMPLEXITIES. AS IN OTHER PARTS OF THE NRTS, HOWEVER, THERE DOUBTLESS ARE LOCAL COMPLEXITIES THAT WOULD INTRODUCE A FACTOR OF UNCERTAINTY IN PROBLEMS THAT INVOLVE THE HYDRAULIC GRADIENT AND LOCAL DIRECTIONS OF GROUND-WATER UNDERFLOW AT SPECIFIC LOCATIONS.

2. THE SLOPE OF THE WATER TABLE (HYDRAULIC GRADIENT) IS ABOUT 4 TO 6 FEET PER MILE.

3. THE DIRECTION OF SLOPE OF THE WATER-TABLE AT TEST-HOLE 24 IS BETWEEN SOUTH AND SOUTHEAST. WITHIN 1 MILE OF THE TEST SITE THE PRINCIPAL REGIONAL DIRECTION OF GROUND-WATER UNDERFLOW PROBABLY IS WITHIN A FEW DEGREES OF SOUTH-SOUTHEAST. BECAUSE THE WATER-BEARING MATERIAL IS NON-HOMOGENEOUS, THE DIRECTION OF GROUND-WATER UNDERFLOW LOCALLY MAY DEVIATE CONSIDERABLY FROM THE GENERAL DIRECTION. FOR SHORT DISTANCES THE DIRECTION OF UNDERFLOW MAY RANGE ANYWHERE BETWEEN SOUTHEAST AND SOUTH-SOUTHWEST.

4. THE VELOCITY OF UNDERFLOW IS NOT KNOWN. FLOW OF WATER IN PARTS OF THE AQUIFER PROBABLY IS TURBULENT. FOR THE SNAKE RIVER PLAIN AS A WHOLE INDIRECT EVIDENCE INDICATES THAT UNDERFLOW VELOCITIES IN THE BASALT RANGE FROM A FEW FEET TO SEVERAL HUNDRED FEET PER DAY.

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CONSTRUCTION AND LOCATION OF PRODUCTION WELLS

THE RANGE OF PERMEABILITY IN THE SNAKE RIVER BASALT IS LARGE, BOTH VERTICALLY FROM LAYER TO LAYER, AND LATERALLY WITHIN INDIVIDUAL LAYERS. LOCALLY BEDS OF FINE-GRAINED SEDIMENT ARE INTERCALATED BETWEEN BASALT LAYERS AND THESE SEDIMENTS IMPEDE THE FLOW OF WATER. WHERE THE BEDS OF SEDIMENT ARE THICK DEEP DRILLING MAY BE NECESSARY TO REACH PERMEABLE WATER-BEARING ZONES.

FAVORABLE CONDITIONS ENCOUNTERED IN TEST-HOLE 24, SUCH AS ABSENCE OF SEDIMENTS IN THE ZONE OF SATURATION, DO NOT ASSURE THAT EQUALLY FAVORABLE CONDITIONS PREVAIL THROUGHOUT THE ANPR SITE. THE WRITER IS CONFIDENT, HOWEVER, THAT CONDITIONS ARE FAVORABLE FOR THE CONSTRUCTION OF EFFICIENT PRODUCTION WELLS WITHIN A FEW THOUSAND FEET OF THE TEST SITE.

LARGE-BORE WELLS DRILLED 100 TO 150 FEET BELOW THE WATER TABLE IN MATERIALS SIMILAR TO THOSE AT THE TEST-HOLE SITE WOULD YIELD UP TO 1,000 GPM EACH WITH DRAWDOWNS OF LESS THAN 5 FEET. DEEPER DRILLING MAY BE NECESSARY IF MUCH IMPERMEABLE BASALT OR SEDIMENT IS ENCOUNTERED BELOW THE WATER TABLE. GEOLOGICAL SURVEY TEST HOLE 7, IN THE NW¼NE¼ SEC. 27, T. 6 N., R. 31 E., IS 1,200 FEET DEEP AND PENETRATES CHIEFLY BASALT BELOW THE WATER TABLE, WHICH IS 212 FEET BELOW THE LAND SURFACE. WATER-BEARING ZONES ARE PRESENT THROUGHOUT THE COLUMN OF ROCK DRILLED BELOW THE WATER TABLE, AND EXTREMELY PERMEABLE MATERIAL WAS STRUCK NEAR THE BOTTOM OF THE WELL.

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IT IS RECOMMENDED THAT CONSTRUCTION OF WELLS DRILLED CHIEFLY IN BASALT AT THE ANPR SITE BE SIMILAR TO THAT OF WELLS AT THE CPP AND STR SITES. CASING SHOULD BE INSTALLED TO OR BELOW THE LEVEL AT WHICH THE INTAKE PIPE OF THE PUMP WILL BE SET. THE PUMP BOWLS SHOULD BE AT LEAST 25 FEET BELOW THE STATIC WATER LEVEL IN THE WELLS. THE PART OF THE HOLE BELOW THE PUMP SETTING NEED NOT BE CASED UNLESS IT IS IN UNSTABLE MATERIALS THAT MIGHT CAVE AND FILL THE UNCASED HOLE. PERFORATIONS IN THE CASING SHOULD PROVIDE AT LEAST SEVERAL SQUARE FEET OF ENTRANCE AREA FOR WATER, WITH THE HIGHEST PERFORATIONS BELOW THE EXPECTED LEVEL OF WATER IN THE WELL DURING PUMPING. THE ANNULAR SPACE BETWEEN THE CASING AND THE WALL OF THE HOLE SHOULD BE FILLED WITH CLEAN PEBBLE GRAVEL FROM JUST ABOVE THE STATIC WATER LEVEL TO THE BOTTOM OF THE CASING. THE GRAVEL PACK IN THIS TYPE OF WELL IS SOLELY FOR PROTECTIVE PURPOSES; THAT IS, IT SUPPORTS AND STABILIZES THE CASING AND PREVENTS CLOGGING OF PERFORATIONS BY FINE MATERIAL THAT MAY CAVE OR BE INTRODUCED FROM ABOVE. ABOVE THE GRAVEL PACK THERE SHOULD BE A CEMENT SEAL, AND THE REMAINDER OF THE SPACE AROUND THE CASING SHOULD BE FILLED WITH PUDDLED CLAY OR NATIVE EARTH MATERIAL OF LOW PERMEABILITY.

FOR A WELL OF THE DESIRED CAPACITY THE MINIMUM FEASIBLE SIZE OF CASING TO THE DEPTH OF THE PUMP SETTING IS ABOUT 16 INCHES O. D. WITH SMALLER CASING THE CHANCE OF WEDGING THE PUMP BOWLS BY FOREIGN OBJECTS ACCIDENTALLY DROPPED IN THE WELL IS TOO GREAT. ALSO, IF THE

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PUMP COLUMN WERE DROPPED DURING INSTALLATION OR REMOVAL FOR REPAIR, SMALLER CASING WOULD NOT ALLOW MUCH ROOM FOR MANIPULATING FISHING TOOLS. SIXTEEN-INCH CASING WOULD PROVIDE ROOM FOR A PUMP LARGE ENOUGH TO SUPPLY THE DESIRED QUANTITY OF WATER. IF FUTURE CONTINGENCIES INCLUDE POSSIBLE INSTALLATION OF A LARGER PUMP, 18-INCH CASING WOULD ACCOMMODATE A PUMP THAT COULD DELIVER 2,000 TO 3,000 GPM.

PROPERLY CONSTRUCTED 16- AND 18-INCH WELLS IN PERMEABLE BASALT PROBABLY WILL YIELD 1,000 TO 3,000 GPM WITH A DRAWDOWN OF LESS THAN 25 FEET. THE EXPECTED TOTAL PUMPING LIFT THEREFORE IS LESS THAN 350 FEET. THE HYDROLOGY OF THE ANPR AREA IS POORLY KNOWN, HOWEVER, AND EXPERIENCE IN HIGHLY PRODUCTIVE AREAS ELSEWHERE SHOWS THAT 10 TO 20 PERCENT OF WELLS ARE RELATIVELY POOR PRODUCERS. NEVERTHELESS WELLS REGARDED AS "POOR" IN THIS AREA ARE POOR ONLY BY LOCAL STANDARDS. BY AVERAGE STANDARDS ALL ARE GOOD TO EXCELLENT PRODUCERS.

IT IS RECOMMENDED THAT PRODUCTION WELLS FOR THE ANPR FACILITY BE LOCATED IN THE SECTOR BETWEEN NORTHWEST AND NORTHEAST OF TEST-HOLE 24, AND PREFERABLY AT LEAST 500 FEET FROM THE TEST HOLE. THE LOCATION FOR THE TEST WAS SELECTED IN ANTICIPATION THAT PRODUCTION WELLS WOULD BE TO THE NORTH. ASSUMING THAT WASTE-DISPOSAL FACILITIES NECESSARILY WILL BE TO THE SOUTH, THIS ARRANGEMENT HAS THE FOLLOWING ADVANTAGES.

1. NORTHWARD THE WATER TABLE RISES MORE RAPIDLY THAN DOES THE LAND SURFACE. THEREFORE THE DEPTH TO WATER ON THE NORTH MAY BE SOMEWHAT LESS THAN IN TEST-HOLE 24, AND THE TOTAL PUMPING LIFT ALSO MAY BE LESS.

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2. THE TEST HOLE IS PART OF A PERMANENT NETWORK OF OBSERVATION AND MONITORING STATIONS THAT HAVE BEEN ESTABLISHED AND MAINTAINED BY THE GEOLOGICAL SURVEY. IT SHOULD BE OUTSIDE THE FENCED (EXCLUSION) AREA OF THE ANPR TO ELIMINATE EXCESSIVE SECURITY PRECAUTIONS DURING PERIODIC VISITS BY SURVEY PERSONNEL.

3. THE TEST HOLE SHOULD BE DOWN THE WATER-TABLE GRADIENT FROM PRODUCTION WELLS, BETWEEN THE PRODUCTION WELLS AND WASTE-DISPOSAL FACILITIES. IN THAT POSITION IT CAN BE USED FOR SEVERAL PURPOSES: (A) TO MONITOR THE CHEMICAL AND RADIOMETRIC QUALITY OF GROUND WATER MOVING THROUGH THE AREA; (B) TO DETECT ENCROACHMENT, IF ANY, OF CONTAMINATED WATER FROM WASTE-DISPOSAL AREAS BEFORE THE CONTAMINATION REACHES THE PRODUCTION WELLS; (C) DURING PUMPING OF PRODUCTION WELLS TO MAKE OBSERVATIONS ON WHICH TO BASE CALCULATIONS OF HYDRAULIC COEFFICIENTS; (D) DURING DISCHARGE OF WATER TO THE GROUND THROUGH DISPOSAL WELLS TO MAKE OBSERVATIONS ON WHICH TO BASE CHECK CALCULATIONS OF HYDRAULIC COEFFICIENTS. DATA (C) AND (D) WILL PERMIT REASONABLY ACCURATE CALCULATION OF THE SAFE SPACING OF PRODUCTION AND DISPOSAL WELLS. AT PRESENT ONLY ESTIMATES OF SAFE SPACING CAN BE MADE.

THE RECOMMENDED DISTANCE BETWEEN PRODUCTION WELLS IS 500 FEET OR MORE. PRESUMABLY ONLY ONE WELL NORMALLY WOULD BE PUMPED AT A TIME. EMERGENCY OR INCREASED WATER DEMAND, HOWEVER, MAY NECESSITATE SIMULTANEOUS PUMPING OF TWO WELLS. MUTUAL INTERFERENCE BETWEEN WELLS LESS THAN 500 FEET APART MAY BE SUFFICIENT TO IMPAIR THEIR EFFICIENCY.

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DEPTH TO WATER AND PUMPING LIFTS

AT RECOMMENDED LOCATIONS NORTH OF TEST-HOLE 24 THE DEPTH TO WATER MAY RANGE FROM 300 TO 325 FEET, DEPENDING ON THE SLOPE OF THE WATER TABLE AND THE ALTITUDE OF THE LAND SURFACE. THE DRAWDOWN IN EFFICIENT PUMPED WELLS MAY RANGE FROM LESS THAN 1 FOOT TO AS MUCH AS 25 FEET, DEPENDING ON THE RATE OF PUMPING, THE PERMEABILITY OF THE AQUIFER, AND THE AMOUNT OF PERMEABLE MATERIAL PENETRATED BY THE WELL. PUMPING LIFTS THUS MAY BE 350 FEET OR LESS. FOR PROPERLY CONSTRUCTED WELLS IN PERMEABLE BASALT THE ESTIMATED AVERAGE PUMPING LIFT IS 325 FEET OR LESS.

CHEMICAL QUALITY OF WATER

DURING PUMPING OF TEST HOLE 24 THE WATER CLEARED WITHIN A FEW MINUTES AFTER DISCHARGE BEGAN. THE WATER TEMPERATURE WAS 50°F. AFTER PROLONGED PUMPING FROM A LARGER WELL THE WATER TEMPERATURE MAY BE ONE OR TWO DEGREES HIGHER. WATER FROM GREATER DEPTHS ALSO IS APPRECIABLY WARMER. WATER PUMPED FROM TEST-HOLE 7, WITH THE PUMP CYLINDER 800 FEET BELOW THE LAND SURFACE, HAD A TEMPERATURE OF 66°F.

SAMPLES OF WATER FROM TEST-HOLE 24 HAVE BEEN COLLECTED, BUT CHEMICAL ANALYSES HAVE NOT BEEN COMPLETED. ANALYSES OF WATER FROM TEST-HOLE 7 ARE AVAILABLE, BUT OWING TO SPECIAL CONDITIONS THE WATER FROM THAT WELL PROBABLY IS NOT REPRESENTATIVE OF WATER THAT WILL BE OBTAINED FROM ANPR WELLS. IT IS BELIEVED THAT THE GROUND WATER AT THE ANPR SITE IS SIMILAR TO THAT PUMPED FROM WELLS ELSEWHERE ON THE NRTS.

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FEASIBLE TYPES OF FLUID-WASTE DISPOSAL

LIMITING GEOLOGIC CONDITIONS.—TERRETON LAKE, THE ANCESTOR OF MODERN MUD LAKE, WAS A LARGE BODY OF FRESH WATER WITH AN EMBAYMENT IN THE NORTHERN PART OF THE NRTS. SEDIMENTS THAT WERE DEPOSITED IN THE LAKE ARE CHIEFLY SILT AND VERY FINE SAND, WITH SOME CLAY. EAST OF TEST-HOLE 24 THE LAND SURFACE IS FORMED BY THESE BEDS, WHILE TO THE WEST IT IS FORMED BY TERRETON LAKE BEDS AND SIMILAR FINE SEDIMENTS THAT ACCUMULATED IN MODERN EPHEMERAL LAKES. THE PERMEABILITY OF ALL THESE SEDIMENTS IS VERY LOW.

A STREAM THAT ENTERED ANCIENT TERRETON LAKE FROM THE SOUTH BROUGHT SILT AND FINE SAND THAT FORMED A BROAD SAND BAR EXTENDING NORTHWARD THROUGH THE CENTRAL PART OF SEC. 13, T. 6 N., R. 31 E., INTO THE SOUTHEAST PART OF SEC. 12, AND THENCE TO THE CENTRAL EASTERN PART OF SEC. 11. PARTS OF THIS BAR ARE QUITE THIN AND LOW. THE AVERAGE EFFECTIVE WIDTH OF THE SAND BAR IS ABOUT 500 FEET, AND ITS EFFECTIVE HEIGHT IS ABOUT 10 FEET. THE SEDIMENTS IN THE SAND BAR ARE SOMEWHAT MORE PERMEABLE THAN THE LAKE-BOTTOM DEPOSITS.

THE SNAKE RIVER BASALT, WHICH UNDERLIES THE UNCONSOLIDATED SEDIMENTS IN THE AREA, INCLUDES MANY HIGHLY PERMEABLE LAYERS THAT CAN ACCEPT AND TRANSMIT WATER VERY READILY. SOME LAYERS OF THE BASALT ARE IMPERMEABLE.

SANITARY WASTE.—IT IS ASSUMED THAT ANPR SANITARY INSTALLATIONS WILL INCLUDE SEPTIC OR IMHOFF TANKS, OR SIMILAR DIGESTION WORKS, DISCHARGING ABOUT 20 GPM OF CLEAR FLUID EFFLUENT. THIS EFFLUENT PROBABLY COULD

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BE DISPOSED BY LEACHING BEDS OR OTHER INFILTRATION WORKS IN THE SAND-BAR SEDIMENTS. THE SAND BAR, HOWEVER, IS UNDERLAIN BY LAKE BEDS OF LOW PERMEABILITY, WHICH WOULD TEND TO PERCH THE DISPOSED WATER. PART OF THE WATER PROBABLY WOULD REAPPEAR AS SEEPAGE ALONG THE BASE OF THE SAND BAR AND MIGHT CREATE A LOCAL SANITATION PROBLEM.

EFFLUENT FROM SEWAGE WORKS MIGHT BE MIXED FOR DISPOSAL WITH INDUSTRIAL FLUID EFFLUENT. THE DILUTION FACTOR WOULD BE LARGE BUT, AS A GENERAL POLICY, THE IDAHO STATE DEPARTMENT OF PUBLIC HEALTH OPPOSES DISCHARGE OF SEWAGE EFFLUENT INTO PERMEABLE ROCKS AT OR NEAR THE WATER TABLE (SEE BELOW).

INDUSTRIAL WASTE.—DISPOSAL OF THE RELATIVELY LARGE VOLUME OF INDUSTRIAL WASTE FLUIDS IS A SPECIAL PROBLEM IN THE ANPR AREA BECAUSE THE UNCONSOLIDATED SEDIMENTS ARE TOO FINE GRAINED TO ABSORB AND TRANSMIT WATER READILY. THE SIZE OF A LEACHING FIELD FOR THIS DISPOSAL WOULD BE EXCESSIVE. ONLY TWO PRACTICAL ALTERNATIVES ARE APPARENT: (1) OPEN SURFACE PONDS, AND (2) INTAKE WELLS.

(1) DISPOSAL MIGHT BE AT THE SURFACE IN LARGE NATIVE DEPRESSIONS, WHERE THE WATER WOULD BE DISSIPATED BY EVAPORATION AND BY SLOW INFILTRATION. SUCH A METHOD WOULD HAVE NUMEROUS IMPORTANT DRAWBACKS: (A) THE WATER ULTIMATELY WOULD INUNDATE OR PERMANENTLY WET SEVERAL HUNDRED ACRES OF LAND. (B) THE WATER WOULD ATTRACT GAME ANIMALS. (C) GROWTH OF WATER-LOVING VEGETATION WOULD BE PROMOTED AND THE AREA WOULD BE VISITED BY WATERFOWL. (D) WILDLIFE INTERESTS PROBABLY WOULD OBJECT

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TO THE ARRANGEMENT. (E) RADIOACTIVE MATERIALS MIGHT ACCUMULATE IN SHALLOW EARTH MATERIALS BY ADSORPTION AND BASE EXCHANGE. ULTIMATELY THE BACKGROUND RADIOACTIVITY IN THE SURFACE SEDIMENTS MIGHT REACH AN UNDESIRABLE LEVEL.

(2) DISPOSAL MIGHT BE IN ONE OR MORE INTAKE WELLS SUNK TO PERMEABLE ZONES IN THE BASALT. THESE ZONES MIGHT BE EITHER ABOVE OR BELOW THE WATER TABLE.

AS A GENERAL RULE THE DISPOSAL OF UNDESIRABLE MATERIALS IN THE GROUND IS INIMICAL TO THE SAFETY OF GROUND-WATER SUPPLIES. THE GEOLOGICAL SURVEY ORDINARILY DOES NOT RECOMMEND SUCH PROCEDURE. IN THIS INSTANCE, HOWEVER, THERE APPEARS TO BE NO PRACTICAL ALTERNATIVE. GROUND DISPOSAL OF WATER THAT CONTAINS NON-TOXIC CONCENTRATIONS OF RADIOACTIVE MATERIALS MAY BE SAFE IF THE AMOUNT AND CONCENTRATION OF RADIOACTIVITY IS CONTROLLED, IF THE EFFLUENT IS ADEQUATELY MONITORED, AND IF THE POINTS OF DISCHARGE ARE PROPERLY LOCATED. THE FOLLOWING SUGGESTIONS ASSUME A NON-TOXIC EFFLUENT THAT IS CAREFULLY MONITORED.

Disposal wells.—A DISPOSAL WELL TO RECEIVE WASTE WATER CAN BE CONSTRUCTED BY DRILLING IN THE SNAKE RIVER BASALT. PERMEABLE LAYERS MAY BE ENCOUNTERED AT ANY DEPTH, AND SUFFICIENT INTAKE CAPACITY MIGHT BE DEVELOPED WITHOUT DRILLING ENTIRELY THROUGH THE ZONE OF AERATION. ON THE OTHER HAND, IT MAY BE DESIRABLE TO DRILL INTO THE ZONE OF SATURATION. BOTH TYPES OF DISPOSAL — IN THE ZONE OF AERATION, AND IN THE ZONE OF SATURATION — HAVE ADVANTAGES AND DISADVANTAGES. THEIR

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RELATIVE MERITS REQUIRE FURTHER STUDY AND IT IS SUGGESTED THAT FINAL SELECTION OF THE TYPE OF DISPOSAL BE DEFERRED TEMPORARILY.

THEORETICALLY A WELL IN HOMOGENEOUS EARTH MATERIAL CAN TAKE IN AS MUCH WATER AS CAN BE PUMPED OUT OF IT, PROVIDED THAT DURING INTAKE A HEAD IS BUILT UP EQUAL TO THE DRAWDOWN CAUSED BY PUMPING. ALSO, INCREASING THE HEAD WILL INCREASE THE INTAKE CAPACITY.

ALTHOUGH THE SNAKE RIVER BASALT IS NON-HOMOGENEOUS, A SATISFACTORY DISPOSAL WELL CAN BE CONSTRUCTED IN ABOUT THE SAME MANNER AS A PRODUCTION WELL, BUT WITHOUT GRAVEL PACKING. ALSO LESS CASING IS NEEDED, AND SMALLER DIAMETER IS ACCEPTABLE. CONSTRUCTION COST CAN BE FURTHER CHEAPENED BY RELAXING ALINEMENT REQUIREMENTS IN THE WELL SPECIFICATIONS. SPECIAL PROVISIONS ARE NECESSARY TO REDUCE AIR TRAPPING.

THE ESTIMATED MINIMUM SAFE DISTANCE FROM 1,000-GPM PRODUCTION WELLS TO DISPOSAL WELLS IS 2,000 FEET. THIS ESTIMATE IS DERIVED FROM CALCULATIONS BASED ON TESTS AND OBSERVATIONS IN THE CPP AREA. CONDITIONS AT THE ANPR AREA ARE NOT STRICTLY COMPARABLE AND THE ESTIMATE OF 2,000 FEET IS FOR INTERIM PLANNING ONLY. AFTER THE FIRST PRODUCTION WELL IS DRILLED, A PUMPING TEST SHOULD BE MADE, AND FROM THIS TEST A BETTER ESTIMATE OF THE SAFE DISTANCE TO A DISPOSAL WELL MAY BE DERIVED.

IN ORDER TO AVOID CONTAMINATION OF ITS OWN WATER SUPPLY, THE ANPR DISPOSAL WELL SHOULD BE DOWN THE WATER-TABLE GRADIENT FROM PRODUCTION WELLS. THE ABOVE ESTIMATE OF SAFE DISTANCE ASSUMES A DISPOSAL WELL DIRECTLY DOWN THE MAXIMUM HYDRAULIC GRADIENT FROM PRODUCTION WELLS. IF ARRANGEMENT OF PLANT FACILITIES REQUIRES A DIFFERENT ARRANGEMENT THE SAFE DISTANCE WILL HAVE TO BE RECALCULATED.

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TABLE 1. CONDENSED DRILLER'S LOG OF TEST-HOLE 24

(TERMINOLOGY SLIGHTLY MODIFIED)

MATERIAL	THICKNESS (FEET)	DEPTH (FEET)
CLAY (CLAYEY SILT)	50	50
BASALT, GRAY. CREVICE AT 64.5 AND 78.5 - 79 FEET	29	79
BASALT, HARD GRAY	21	110
BASALT, MODERATELY HARD GRAY	13	123
BASALT, HARD GRAY	19	142
BASALT, MODERATELY HARD GRAY	3	145
BASALT, MODERATELY HARD; SOME RED BASALT AND RED CINDERS	5	150
BASALT, MEDIUM HARD RED AND GRAY	15	165
BASALT, HARD GRAY	10	175
BASALT, RED AND GRAY	4	179
BASALT, BROWN	8	187
BASALT, RED AND GRAY	3.5	190
BASALT, COARSELY VESICULAR BROWN ("HONEYCOMB"). CREVICE FROM 198 TO 203 FEET	12.5	203
BASALT, BROWN AND GRAY. CREVICE AT 206 FEET	5	208
BASALT, HARD GRAY. CREVICE FROM 206 TO 209 FEET	2	210
BASALT, GRAY	9	219
BASALT, MODERATELY HARD, GRAY. APPRECIABLE AMOUNT OF GROUND WATER IN HOLE AT DEPTH OF 229 FEET	14	233
BASALT, HARD GRAY. DEPTH TO WATER 214 FEET	8	241

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TABLE 1 — CONTINUED

SANDSTONE [?]	2	249
BASALT, BROKEN, WITH SUBSTANTIAL AMOUNT OF WATER. ESTIMATED 90 TO 100 PERCENT OF CUTTINGS NOT RECOVERED FROM VARIOUS INTERVALS. CAVING OCCURRED AT DEPTH OF 249 FEET	14	263
CINDERS, RED. ESTIMATED 80 PERCENT OF CUTTINGS NOT RECOVERED	3	266
BASALT, COARSELY VESICULAR BROWN ("HONEYCOMB"). ESTIMATED 80 TO 100 PERCENT OF CUTTINGS NOT RECOVERED FROM VARIOUS LEVELS	10	276
SAND [?], BROWN, CAVING. MOST OF CUTTINGS NOT RECOVERED	4	280
BASALT, GRAY. ESTIMATED 50 PERCENT OF CUTTINGS NOT RECOVERED	5	285
BASALT, VESICULAR BROWN. MOST OF CUTTINGS NOT RECOVERED	5	295
BASALT, RED, GRAY, AND BROWN. MOST OF CUTTINGS NOT RECOVERED	11	306
BASALT, GRAY. MOST OF CUTTINGS NOT RECOVERED	4	310
BASALT, BROKEN, GRAY. CAVED FROM 324.5 FEET. MOST OF CUTTINGS NOT RECOVERED	16	326